THE CHOLERA

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THE CHOLERA BACILLUS.

THE German government has most commendably recognized the interest of the public in the reports made by the leader of the commission which has been studying the cholera in Egypt and India. The letters already so promptly published are, of course, merely notes of progress sent to the base of supplies; and no detailed and complete report can be expected at present. So far as the results have been made known, the work of the commission is full of promise. For the cholera, which, by the way, is only one of the subjects under investigation, a bacterium, apparently peculiar to the disease, has been found; and its cultivation has shown characteristics sufficiently marked to render its recognition easy. This comma-shaped bacillus has not, thus far, been found in connection with any other disease of the intestinal tract, although numerous examinations relative to this point have been made; and in cholera patients, it was only seen in association with the intestinal disturbance, but here invariably. It has, however, been met with in some sources of water-supply in India, in which the local infection may have originated.

It should not be forgotten that this work of Koch is no mere lucky guess. Bacteria were found by him in material sent to Berlin from India; but it was then impossible to decide how far putrefactive changes had produced them. The commission has now been able to examine a goodly number of fresh cases (fifty-two dead, and forty sick, from cholera), and thus to render the pathogenetic character of the bacillus exceedingly probable; and yet not a little remains to be done to complete the demonstration. The germs do not appear to be very tenacious of life, so that an efficient prophylaxis can be readily exercised; and here a sound digestion becomes of primary importance for the individual. The season of intestinal disturbances is upon us, so that the work of the German commission can readily be supplemented in one direction in any of our hospitals.

SIXTH REPORT OF DR. KOCH OF THE GERMAN CHOLERA COMMISSION, DATED CALCUTTA, FEB. 2, 1884.[1]

THE question, which, in my last report of Jan. 7, was left unanswered, — whether the bacilli found in the intestines affected with cholera are parasites due to cholera alone, — may be looked upon as answered.

It was at first exceedingly difficult, on account of the varying conditions under which the pathological changes took place in intestines affected by cholera, and on account of the great number of bacteria constantly present in them, to find out the bacillus proper to the disease. In most cases death occurred, not at the height of the cholera process, but during the period of reaction immediately following, in which such important changes take place in the condition of the intestines and their contents, that it is impossible, from such cases alone, to gain a clear conception of the cholera process. Only when one has had an opportunity to dissect a number of uncomplicated cases, and to compare with them the conditions exhibited in persons when first attacked, is it possible to gain a correct insight into the pathological conditions of cholera. On this account it was always kept in view, to use the greatest caution in accepting any theory as to the connection of the bacterial condition and the cholera, or as to causal connection of the bacteria with cholera, till the full proof might be obtained.

In the last report, I could already state that the peculiarities of the cholera bacteria were so well determined that they could safely be distinguished from others. Of these characteristics, the following are the most striking: the bacilli are not perfectly straight, like other bacilli, but slightly curved, like a comma. The bending may go so far that they take the form of a half-circle. In the pure cultivation from these bent rods often arise s-formed figures, and more or less long, slightly wavy lines, of which the first are made up of two, and the last of a large number, of the cholera bacilli, which, by continued increase, have remained connected. They possess powers of locomotion, which can best be seen, and in most marked degree, in a drop of cultivation-liquid suspended on a cover-glass: in such a preparation, one sees the bacilli moving with the greatest velocity in all directions through the field.

Especially characteristic is their action when cultivated in gelatine, in which they form colorless colonies, which at first are closed, and appear as if they consisted of very brilliant little glass particles.

[1] Translated from the *Berliner klinische wochenschrift* for March 31.

Gradually these colonies liquefy the gelatine, and spread out to a considerable extent. In gelatine cultivation they are, therefore, through this remarkable appearance, very surely distinguished from other bacteria colonies, and can easily be isolated from them. Moreover, they can pretty surely be distinguished by cultivation in hollow slides, as they always go to the edge of the drop, and in that position can be recognized by their peculiar movements, and, after application of aniline solution, by their comma form.

As yet, twenty-two cholera bodies and seventeen cholera patients have been subjects of investigation. All these cases were studied for the presence of the specific bacteria, as well with gelatine cultivation as also in microscopical preparations, for the most part through cultivation in hollow slides; and, without exception, the comma-shaped bacilli were found. This result, together with that obtained in Egypt, justifies the statement that this kind of bacterium is always to be found in the cholera intestine.

For corroboration, moreover, investigations were carried on in the same way on twenty-eight other bodies (of which eleven had died from dysentery); the evacuations of one case each of simple diarrhoea, dysentery, and of a convalescent from cholera; then from several well people, as well as on animals dead from ulcer in the intestine, and pneumonia; finally, also with putrid masses of impure water (various samples from city sewage, water from very impure swamps, swamp scum, and impure river-water): but in not a single instance did it happen, either in stomach or bowels of the bodies of man or beast, in evacuations, or in fluids rich in bacteria, that the cholera bacteria was found. As by arsenic-poisoning a sickness very similar to cholera can be induced, an animal was killed by arsenic, and, after death, the digestive organs examined for the comma bacillus; but with a negative result.

From these results the further conclusion may be drawn, that the comma bacillus is peculiar to cholera.

As to the connection of this bacillus with cholera, it was carefully stated in the last report, that there may be two views: 1°, that the condition of the organs of a person sick with cholera is such that this peculiar bacillus prospers; 2°, that the bacillus is the cause of the cholera, and that only when it makes its way into the bowels of man can the sickness take place. The first supposition is not allowable from the following grounds: it would be necessary to grant, that, when a man is taken sick with the cholera, this bacillus was already present in his organs, as shown by its universal presence in the considerable cases investigated in Egypt and India, two widely separated lands. This could not be the case, however; since, as has already been pointed out, the comma-shaped bacillus is never found, except in a case of cholera.

Even in cases of bowel affection, such as dysentery and bowel catarrh, to which cholera very often supervenes, they fail. It is also to be considered, that, if this bacterium were always present in man, it would surely have been observed on some occasion; which has not been the case.

As the increase of this bacterium cannot be brought about in the bowels by cholera, the second supposition, that it is the cause of cholera, only remains. That this is, in fact, the case, is shown unquestionably by other facts, and especially by its behavior during the progress of the disease. Its presence is restricted to the organ in which the disease is, — the bowels. In vomit, they have, as yet, only been noticed in two cases; and in both, the appearance and alkaline reaction of the vomited fluids showed that the contents of the bowels, and with these the bacteria, had got into the stomach. In the bowels their history is as follows: in the first evacuations of the patient after the attack, as long as they have any form, very few cholera bacilli are present; the watery, odorless evacuations which follow, on the contrary, contain the bacilli in great numbers; while, at the same time, all other forms disappear almost entirely, so that, at this stage, the cholera bacilli are cultivated practically alone in the bowels. So soon as the cholera attack lessens, and the evacuations are again fecal, the comma bacteria disappear gradually, and are, after the convalescence, no longer to be found. The same is found to hold in cholera subjects. In the stomach no cholera bacilli were found. The bowels varied, according as death had occurred during the cholera attack or after it. In the freshest cases, the bowels showed a clear, red color; the inner lining of the intestines was still free from submucous extravasation; and the contents consisted of a colorless, odorless liquid: the cholera bacilli were present in enormous masses, and nearly pure. Their distribution corresponded exactly with the degree and spread of the inflammation of the lining-membrane, the bacilli being generally not so thick in the upper intestine, but increasing toward the lower end of the smaller intestine. When, however, death has taken place later, the intestines show signs of an important reaction. The lining is dark red in the lower part of the smaller intestine, impregnated with extravasations of blood, and often dead on the outermost layers. The contents of the bowels are, in such cases, more or less blood-colored, and, in consequence of the re-appearance of the bacteria of decomposition, putrid and fetid. The cholera bacteria at this stage begin to disappear, but continue still to be present for some time in the solitary glands and in their vicinity, — a circumstance which first called attention to the presence of this peculiar bacterium in the bowels of the Egyptian cholera subjects. They entirely fail in such cases, only when the patient has lived through the cholera, and dies from the after-weakness.

The cholera bacteria act exactly as other pathological bacteria. They occur only in their peculiar disease; their first appearance is when the illness begins; they increase in number with the severity of the attack, and gradually disappear as the illness wanes. They are found where the trouble exists; and their number, at the height of the disease, is so great, that their injurious effect on the lining of the intestines is explained.

It might well be wished that it were possible, with these bacteria, to engender in animals a disease akin to cholera, that their causal relation to the sickness might be made the more clear. This has, as yet, not been done: whether it will ever be done may well be questioned, as animals do not appear to be subject to cholera infection. If any kind of animal could take the cholera, then such a case would have been observed in Bengal, where, during the whole year, and over the whole country, cholera infection is spread. But all reported cases have, as yet, failed of corroboration. Nevertheless, the evidence of the facts produced cannot be weakened by the failure of the experiments on animals. With other infectious diseases, the same observation has been made; for example, in the case of typhoid fever and leprosy, — two diseases for which specific bacteria are known, without, as yet, its being possible to communicate them to animals; and yet the manner of the occurrence of the bacteria in these diseases is such, that, without doubt, they must be looked upon as the cause of the disease. The same holds true for the cholera bacteria. Moreover, the further study of the cholera bacteria has made known many of their peculiarities, which all agree with that which is known of cholera etiology, as well as further evidence of the correctness of the assumption of the bacteria as the cause of the disease.

In this connection it is well to state the often observed fact, that in the linen of cholera patients the bacteria increase in a most remarkable manner, when the clothes have been soiled with the evacuations, and then, for twenty-four hours, have been kept in a moist condition. This explains the known fact, that the people having to do with such affected linen are often attacked. On account of this, further experiments were instituted; and cholera evacuations, or the contents of the intestines of the dead, were spread on cotton, on paper, and especially on the damp surface of the ground. After twenty-four hours, the thin sheet of slime invariably changed into a thick mass of cholera bacilli.

Another peculiarity of the cholera bacteria is, that they die, upon drying, much more quickly than most others. Commonly all life is extinct after three hours' drying.

It has also been noticed that their development only takes place well in substances having an alkaline reaction. A very small amount of free acid, which would have little or no effect on other bacteria, puts a marked check on their growth.

In a healthy stomach they are destroyed, which is shown by the fact that neither in the stomach nor the intestines of animals which had been constantly fed on cholera bacilli, and then killed, were any found. This last peculiarity, together with the impossibility of their withstanding drying, gives an explanation of the every-day observation, that infection so seldom occurs from constant intercourse with cholera patients. Evidently, that the bacilli may be in condition to pass the stomach, and bring about the cholera in the intestines, peculiar conditions must be present. Perhaps, when the digestion is imperfect, the bacilli might be able to pass the stomach; and the fact observed in all cholera epidemics and in India, that those suffering from indigestion are especially subject to cholera, may bear out this view. Perhaps a peculiar condition, analogous to the period of inaction of other bacteria, would enable them to pass the stomach uninjured.

It is, on the whole, not probable that this change in the production of inactive spores exists: then such spores, by observation, are known to remain months, or even years, capable of life, while the cholera poison remains active not longer than from three to four weeks. Nevertheless, it is conceivable that some other form of inactivity exists, in which the bacilli can retain their life in a dry state some weeks, and in which they withstand the destroying influence of the stomach.

The conversion into such a condition would correspond with that which Pettenkofer has designated as ripening of the 'cholera-infection material.' As yet, such an inactivity of cholera bacilli has not been discovered.

— The *Kölnische zeitung* of April 10 states that Dr. Koch has submitted a seventh report, dated Calcutta, March 4. It mentions the important discovery that the storage-basins called tanks have proved the locally limited seat of cholera infection and communication. Little ponds or swamps, scattered over all Bengal in large numbers, surrounded by cottages, furnish to the dwellers near them their water-supply, and are used for various purposes, — as for bathing, clothes-washing, for cleaning domestic utensils, and also for drinking-water. After the commission had in vain sought for the cholera bacillus in numerous trials of tank, sewage, and river water, they are discovered for the first time in a tank in the midst of the cholera district. Since the last report, the bodies of twenty cholera victims, and the excrements of eleven patients, have been examined. The whole number of cases examined in India now amounts to forty-two dead bodies and twenty-eight patients. The last cases have not, to be sure, yielded new results. They resemble the others in every particular, especially in reference to the behavior of the bacilli. In addition, there are still in progress investigations concerning the influence of various substances — as sublimate, carbolic acid, and other disinfectants — on the development of the cholera bacilli in culture-fluids; also concerning their behavior in carbonic acid, and deprived of air. Attempts to discover a lasting form of the bacillus were also continually made. Up to the present time, nothing of the kind has been discovered. The only possibility of getting bacilli capable of living a longer time is to keep them from drying. In liquids they remain for weeks capable of development, and every thing seems to indicate that only in a moist condition can they be preserved, and then made to act on human bodies. Unfortunately, on account of the warm weather, which this year begins early, further investigations on this subject must be abandoned. Dr. Koch is returning to Europe.

THE ORGANISMS OF THE AIR.[1]

So much that has been written on the subject of the bacteria is merely a recapitulation of what has already been done, or a presentation of results based upon insufficient observations, that it is a pleasure to find a work filled with careful investigations carried out on an extensive scale.

The book before us contains no new or startling discoveries, but rather gives an almost mathematical proof of certain generally received ideas on the distribution of the microbia, and serves conclusively to refute certain errors which have been widely accepted.

The facts have been obtained by a daily analysis of the air taken in the Parc de Montsouris, near Paris. For the sake of comparison, air has also been taken from the centre of the city, the hospitals, and sewers.

After a brief historical sketch of the subject, comes a description of the organic and inorganic particles which have been deposited from the air, and which can be distinguished by aid of the microscope. Among the most interesting of the inorganic constituents are minute fragments of meteoric iron, which can be collected by passing a magnet over the dust, and of which Mr. Tissandier has made a special study. From the organic world are found vessels and bits of plants, as well as the cast-off shells of infusoria and their eggs, as proved by cultivation.

In order to study the particles suspended in the air itself, they must first be collected by aspirating a given quantity over a thin glass covered with glycerine, and then carefully examining the deposit. The cells thus obtained can be roughly divided, for purposes of classification, into four classes:—

1. Grains of starch.

2. Inert pollen of phanerogams, and the zoospores of unknown algae and cryptogams.

3. Spores of cryptogams and zoospores capable of producing a perfectly determinate alga, lichen, or other fungus.

4. Entire vegetables, usually unicellular plants, among which are to be noticed the green algae, the conidia, the yeasts, the *débris* of confervoids, diatoms, etc.

The starch comes mostly from the manufactures, but also from natural sources.

The pollen is never found germinating in the air, however humid this may be. It is most abundant in spring and summer, and almost disappears during the autumn and winter. During the summer it exists to the number of from five thousand to ten thousand in every cubic metre of the atmosphere.

The spores of the cryptogams and algae appear during the damp months of April and May, and reach their greatest numbers in the latter part of June. They persist during the summer, and fall off during the autumn, to become as rare in winter as the pollen. The number varies from seven thousand in a cubic metre in December, to thirty-five thousand in summer. Fluctuations are found dependent upon damp or dry weather, the action of which, however, differs with the time of year. During a cold and wet period in winter, the spores sink to their minimum, while during the dry time the air is greatly enriched, but chiefly by old spores. In the summer, on the contrary, during damp days, the fructifications of the cryptogams are everywhere distributed in abundance.

"The average of the spores collected by the aeroscope is about fourteen thousand per cubic metre. These figures are not excessive, and it is to be hoped that they will settle the contradictory opinions in this regard which have been expressed during the past twenty years. They will go to confirm in their ideas the partisans of the germ-theory, and will show to the few defenders of spontaneous generation how useless it is to invoke the doctrine of heterogenesis to explain the appearance of the mucidines in the liquids and on the substances fitted to maintain their life."

From an etiological and hygienic point of view, it does not seem that such diverse spores, introduced into the economy at the rate of thirty thousand a day, or one hundred million a year, are absolutely innocuous. The development of soor in the mouths of infants and in the respiratory tract of the dying show that the fungi also belong to parasites ready to invade the human organism when there is presented a point of feeble resistance.

The analysis of the air taken from the sewers showed about the same amount of organized material, with the exception of the almost entire absence of starch.

The remainder of the book is devoted to a study of the bacteria present in the air. This is the part which will naturally be of the greatest interest, from the relations which these minute organisms bear to disease and to the processes of putrefaction and fermentation.

Chapter iii. is devoted to a statement of the experiments of Pasteur and others, proving conclusively the existence of germs in the air, which alone are responsible for changes in the liquids into which they fall, and thus setting at rest the question of 'spontaneous generation.'

The classification of the bacteria receives a valuable contribution as the result of long and carefully conducted experiments. The author is convinced of the immutability of the species, but shows that they are capable of great variations under different conditions, and that without great watchfulness 'species' can be easily multiplied. The genera which are usually recognized, and which he accepts, are Micrococcus, Bacterium, Bacillus, Vibrio, and spiral Microbia. Even these genera cannot always be distinguished apart with certainty by their form alone. The characters which serve to differentiate them are briefly as follows: Micrococci and Bacteria never produce spores, Bacilli do; Micrococci are immovable, Bacteria are movable; Vibrios and Spirilla have an undulated or twisted form.

The methods of obtaining the spores from the air

[1] *Les organismes vivants de l'atmosphère.* Par M. P. MIGUEL, chef du service micrographique à l'observatoire de Montsouris. Paris, *Gauthier-Villars*, 1883. 8 + 310 p. 8°.

and the sterilization and preparation of the liquids proper for their development, are the subject of the next chapter. This, as all other parts of the work, shows the results of infinite care and patience. National prejudice is, perhaps, the reason why the solidified meat-extracts and blood-serum have not been employed for the cultivation of the spores. But it is perhaps fortunate for the progress of science that such prejudices exist, as each method is developed to its greatest extent, and the exact value of the one can be controlled by the other. The liquid nutritive material has certainly received a most thorough trial

to germinate at a constant temperature of 35° C. If five or six groups of experiments are made in the same day and place, the results are almost identical, provided that the force and direction of the wind are constant, and, above all, if the air has not been purified by rain or snow. From this, the equal distribution of spores is proved, and not that they are in so-called 'clouds,' as has been maintained by Tyndall.

Signs of germination may appear within twenty-four hours; but it is usually from the second to fourth day that the greatest number of flasks are altered. From

PASTEUR'S LABORATORY. — THE WARM ROOM FOR THE CULTURE OF MICROBES.

"Perhaps the most curious sight is the large number of glass tubes distributed everywhere through the laboratory. In the solutions contained in the tubes, swarm millions and millions of microbes in various stages of 'attenuation;' and a prick from a pin-point dipped in any one of them might confer a horrible disease or future immunity from it. Yet in the midst of such dread possibilities the devoted experimentalist moves unharmed."

in the hands of Mr. Miguel, and the results obtained by its use are not to be thrown lightly to one side. There are infinite sources of error when experimenting with the 'infinitely small;' and the precautions which have been found necessary from these extended observations should caution those observers who have only limited means at their command against hasty generalization. One of the most important safeguards is the proper 'firing' of the flasks which are to receive the culture. Experience has shown that they should be heated during four hours at 200° C.; and then, after having been charged with the 'bouillon,' they should stand for two months at 35° C. in a constant temperature apparatus. At the end of that time those which have retained their limpidity are regarded as sterile, and ready to be sown.

In order to obtain the number of spores distributed in the atmosphere, equal amounts of air are drawn over these sterilized solutions, and are then allowed

this time there is a rapid decrease until the thirtieth day, after which any alteration rarely takes place. The growth is manifest to the unaided eye in three different ways: —

1°. The liquid preserves its clearness, but a more or less voluminous deposit occurs at the lower part.

2°. The liquid is uniformly clouded at first, and then a veil arises, or a deposit is formed.

3°. The liquid remains transparent, but little isolated white clouds of silky mycelium appear, which can invade the entire fluid. These are usually fungous growths, but there are several filamentous microbia which can give rise to the same appearance.

In the flasks which are altered by these aerian spores, there rarely is perceived that nauseating cadaveric odor of intense putrefaction, produced by inoculating a drop of water from a sewer or even from the Seine. The bacteria of the air are only feeble and superficial putrefactors, and rarely cause a profound decomposition of the liquids into which

they are introduced. It is necessary to banish from the mind the idea that we live literally besieged by organisms always ready to sow putrefaction on the mucous tract of our economies. The inhabitants of the country, more privileged in this respect than the dwellers in the city, hardly introduce into their lungs, in the course of a day, one germ of putrid fermentation.

The degree of alterability of the nutritive liquid should always be taken into account in experiments; and numerous investigations were made on this point. From these it appeared that an infusion of hay was the least susceptible of alteration, while neutral beef-bouillon, with the addition of one per cent of salt, was the most so. Normal urine held a middle place. These had been sterilized by boiling for two hours at 110° C. Contrary to general expectation, egg-albumen, diluted with water and sterilized by filtration through plaster, was found to be almost as resistant as the infusion of hay.

In order to cultivate the bacteria in a state of purity, a drop of one cultivation is transferred to another sterilized flask on the point of a 'fired' platinum needle. The danger of infection from the air, during the time the flasks are opened to permit the transfer, is very much less than is generally supposed. By computation the chances are only as 1 to 1,500.

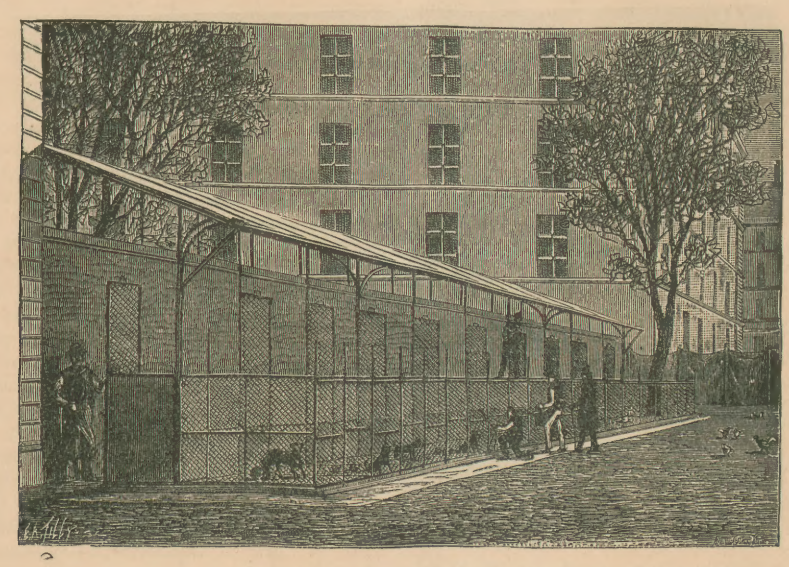
The results of the daily examination of the air at Montsouris during three years showed that bacteria and their spores were more abundant during hot weather than cool, and were inversely proportional to the degree of moisture. The direction of the wind was also of consequence, that which had traversed Paris being richer than that coming from over the country.

In respect to the seasons, the greatest number of germs were found during the autumn, then followed summer and spring, and lastly came winter, as the following table shows: —

Autumn	.	.	.	121	spores	per	cubic	metre of air.
Summer	.	.	.	92	"	"	"	" " "
Spring	.	.	.	73	"	"	"	" " "
Winter	.	.	.	53	"	"	"	" " "
Or a mean of		.	.	84	"	"	"	" " "

The germs which thus find their way into the air are either carried there when dry, or are taken up with fine particles of water by the wind: they never pass off with the insensible evaporation of a fluid. A series of ingenious experiments with the condensations from putrefying liquids and substances proved the truth of this assertion.

The comparative analysis of the air taken from the streets near the centre of Paris showed that it was



KENNELS FOR MAD DOGS.

" 'At this very moment experiments [upon the prevention of hydrophobia] are under full headway. Biting dogs and bitten dogs fill the laboratory. Without reckoning the hundreds of dogs which within three years have died mad in the laboratory, there is not a case discovered in Paris of which Pasteur is not notified. "A poodle and a bull-dog [*bouledogue*] in the height of an attack; come!" was a telegram sent to him recently.' Pasteur went, and took our author with him. The two dogs were rabid '*au dernier point*,' and it was only after some time and no small trouble that they were bound securely to a table. M. Pasteur then bent over the frothing head of the bull-dog, and sucked into a pipette a few drops of saliva. Our author remarks, in conclusion, that Pasteur never appeared to him so great as in the cellar where this took place, and while this '*tête-à-tête formidable*' was being enacted."

nine or ten times richer in schizophytes than that from the Montsouris Park.

In regard to the relation of the bacteria in the air, and the occurrence of epidemics of disease, the fact was observed, that, at the time when there was a comparative increase of deaths from zymotic disease, there was an unusually large number of germs in the air. As it is impossible at present to distinguish harmless from pathogenic microbia, and as the inoculation of cultures from atmospheric spores gave nearly negative results, the author wisely does not lay great stress upon this coincidence.

The interiors of houses were next made the subject of investigation. It was found, that, in a room which was perfectly still and undisturbed, there were 27 microbia to the cubic metre, against 97 in the air outside. The number in the same space in the author's laboratory was found to be 215 in 1880, 348 in 1881, and 550 in 1882. In an ordinary bedchamber in Paris, regarded as sufficiently clean, there was found, in the spring of 1882, 3,830, and, in the winter of 1882, 6,500; giving a mean of 5,260 to the cubic metre. A comparison with the air of a room used for a study in the observatory at Montsouris showed, for the spring of 1882, 270, and, for the winter of 1882, 380; giving a mean of 325 to the cubic metre. From this it at once appears that the air of the house in Paris was sixteen times as impure as that at Montsouris. The decrease in the number of germs from winter to spring is the reverse of what is observed out of doors, and is to be attributed to the more thorough ventilation during the warm months.

The same relation was found in the air from hospitals, except that the numbers were very much higher; varying from 4,500 in summer, to 24,000 in winter, per cubic metre. The micrococci were found to be most abundant here; every hundred germs furnishing, on an average, ninety-one against five bacteria and four bacilli. The inoculation of these, however, was without result.

The air and water from the sewers gave interesting results. A cubic metre of the former furnished from 800 to 900 microbes, while a litre of water taken at the point where it was discharged gave 80,000,000. In this relation it was found that a litre of water condensed from the atmosphere held about 900, a litre of rain-water 64,000, a litre of the Seine at Bercy 4,800,000, while, after the river had traversed Paris, a litre was found to contain 12,800,000. From this it can be understood how easily stagnant water of a sewer can putrefy, and how essential it is that there should always be a current flowing to prevent this. In the air of sewers it is the bacteria proper which abound, but they were without effect when inoculated in animals.

In the ordinary dust of houses it was estimated, after careful weighing and cultivation, that each gram contains about 750,000 spores. A sufficient number of analyses of the soil have not been made as yet, but those made give an average of from 800,000 to 1,000,000 for each gram of earth. In the deeper layers the bacilli preponderate over all other forms, while on the surface the micrococci are most abundant.

Antiseptic substances are last considered; and these are regarded as acting in two ways, — first by destroying the bacteria already in activity, and, secondly, by preventing the germination of spores.

Of such substances, oxygenated water (H_2O_2) was found to be the most powerful, then solution of corrosive sublimate and nitrate of silver. After these come a long list of less efficacious ones. The only compounds which were capable of destroying germs in their dry state by means of the vapor given off were bromine, chlorine, hydrochloric and hyponitric acids.

Such is a brief summary of the principal points touched upon in this book. It is not quite so clearly and concisely written as might be wished; but it is a valuable contribution to science, and must serve as a model for any one who undertakes work in this direction. A careful perusal of the book itself is certainly to be recommended to all interested in the subject.

DR. GEORGE M. STERNBERG ON PROTECTION.

At the start the author incidentally draws a subtle distinction, which may or may not be generally acceptable (p. 236), — "The practical results of etiological studies, so far as the prevention and cure of disease are concerned, are likely to be much greater than those which have been gained by the pathologists," — adding directly in a tone of liberal conservatism, which no one can help admiring, especially as it comes from one who is in the advancing column, "And if the time ever comes, as now seems not improbable, when we can say with confidence, infectious diseases are parasitic diseases, medicine will have established itself upon a scientific foundation. But this generalization, which some physicians think is justified even now by the experimental evidence which has been so rapidly accumulating during the past decade, would, in the opinion of the writer, be premature in the present state of science. And for the present it seems wiser to encourage additional researches, rather than to attempt to generalize from the data at hand. . . . Those who have had the most experience in this difficult field of investigation are commonly the most critical and exacting with reference to the alleged discoveries of others."

Dr. Sternberg sees clearly enough that one of the most interesting theoretical questions in this whole subject which remains still unsolved is, how does inoculation or vaccination protect? or, in his own words, what is "the rationale of the immunity produced by protective inoculations? . . . Recovery, after inoculation with attenuated virus, is more easy to understand than is the subsequent protection" (p. 241).

Lecturers upon the subject often pass lightly over this point, and, by a comparison with a fermentation in a barrel of cider for example, say, "And just as

a barrel of apple-juice can ferment but once under the same germ, so a man usually has the small-pox but once;" the idea being implied, that, as the alcoholic ferment has eaten up its food in the barrel, so the hypothetical small-pox plant has taken out all the available food-material from man, its living prey. Pasteur maintains a position like this; while Sternberg denies that it is a satisfactory explanation, and brings forward a lengthy argument in opposition, some of the points of which do not seem to us well taken. It is, however, the sufficient and fatal objection to the line of thought outlined above, that, while the barrel of apple-juice is a not-living medium, the living organism is undergoing constant repair, is even growing (in the technical sense) till death comes, and is therefore no fixed quantity, either in composition or condition. Dr. Sternberg would solve the problem by considering the acquired protection to be a 'tolerance,' a 'resistance' of the protoplasm to the new condition; e.g. (pp. 248–249), "during a non-fatal attack of one of the specific diseases, the cellular elements implicated, which do not succumb to the destructive influence of the poison, acquire a tolerance to this poison."

This would explain a temporary immunity, — would prevent a patient from 'giving' the disease to himself over and over again, — but would not explain a life-long immunity, since new, and perhaps non-tolerating, non-resisting cells are being constantly produced from the old ones. The cells which actually suffered are therefore supposed by Dr. Sternberg to "acquire a tolerance to this poison, which is transmissible to their progeny, and which is the reason of the exemption of the individual from future attacks of the same disease."

This hypothesis is certainly clear, and it is only befogged by the author's illustration (?) drawn from budding and grafting.

In view of the fact that bacteria are now believed to do their work largely by producing a genuine not-living poison which affects the living cells, the following is of interest: —

"The tolerance to narcotics — opium and tobacco — and to corrosive poisons — arsenic, which results from a gradual increase of dose, may be cited as an example of acquired tolerance by living protoplasm to poisons which at the outset would have been fatal in much smaller doses.

"The immunity which an individual enjoys from any particular disease must be looked upon as a power of resistance possessed by the cellular elements of those tissues of his body which would yield to the influence of the poison in the case of an unprotected person."

The reader must recollect, however, Huxley's discussion of 'aquosity' and 'horology,' and remember that in such sentences as the following we are doing little more than formulating our ignorance: —

"The resistance of living matter . . . is a property depending upon vitality."

The question is often raised, Where do the pathogenic bacteria come from? Dr. Sternberg says, in this connection, —

"If we suppose that under certain circumstances the conditions relating to environment approach those which would be found within the body of a living animal, we can easily understand how a micro-organism which has adapted itself to these conditions may become a pathogenic organism when, by any chance, it is introduced into the circulation of such an animal. The culture fluid — blood — and temperature being favorable, it is only a question of superiority by vital resistance on the one hand, or by reproductive activity on the other.

"That harmless species of bacteria may develop pathogenic properties in the manner indicated seems extremely probable; and we should *a priori* expect that such a result would occur more frequently in the tropics, where the elevated temperature and abundance of organic pabulum furnish the favorable conditions required. In this way, we may, perhaps, explain the origin of epidemics of pestilential diseases, such as yellow-fever and cholera. If these diseases do not at the present day originate in the manner indicated, they, at all events, have their permanent abiding-place in tropical countries."

PROPAGATION OF TUBERCULOSIS.

The influence of heredity and contagion on the propagation of tuberculosis, and the prevention of injurious effects from consumption of the flesh and milk of tuberculous animals. By A. LYDTIN, Carlsruhe, veterinary adviser to the Baden government; G. FLEMING, LL.D., F.R.C.V.S., principal veterinary surgeon to the British army; and VAN HERTSEN, veterinary surgeon, and chief inspector of the Brussels abattoir. New York, *Jenkins*, [1884]. 175 p. 8°.

THIS volume is a translation, by one of the committee upon its preparation, of a report prepared for discussion at the International veterinary congress, held at Brussels in September, 1883. The question of the etiology of tuberculosis is one of the most important of modern medicine, and occupies the attention of a large part of the profession to-day. Its importance is not confined to the human race, in so far as it attacks mankind; but, being so wide-spread among domestic animals, it necessarily affects humanity in this direction also.

The report before us is a valuable summary of the condition of scientific knowledge at the present day, upon this question, in its relationship to domestic animals, and, through them, to mankind. It begins with an account of the nomenclature of the disease from the earliest times to the present, discusses the best means of diagnosis, the course and the anatomical appearance of the disease. In regard to the latter point, the conclusion already generally accepted by medical men is reached, that the

'criterium' of the disease must be sought in the irritant which causes it, and that this irritant is found in the bacillus of Koch. In connection with this portion of the report, there is a very good discussion of the predisposing causes of the disease (pp. 35–49), followed by a consideration of the animals (other than cattle) that are known to be subject to attack by it. The conclusion is reached, after all this, that "tuberculosis is, of all maladies affecting the domesticated animals, that which is the most wide-spread, and which, of all others, most deserves the qualification of 'panzooty.'"

The second chapter of the book is devoted to a consideration of the question, "What is the influence of heredity on the propagation of tuberculosis?" (pp. 55–68.) After the consideration and quotation of many cases and authors, a number of conclusions are reached, of which the last seems to contain the essence, — "that tuberculous parents may transmit to their progeny a predisposition to tuberculosis."

The second question, "What is the influence of contagion on the propagation of tuberculosis?" receives very thorough consideration. A large number of authors — from Ruhling in 1774, to Villemin and Koch in our own day — are cited to prove the contagious nature of the disease. A summary of the reasons for the opinion that animal and human tuberculosis are one and the same is given (pp. 85–98); and this portion of the work is concluded by a short *résumé* of Koch's labors on this disease.

The discussion of the third question, "What are the preventive measures which should be had recourse to, in order to arrest the injurious effects which may result from the use of the flesh and milk of tuberculous cattle?" is opened with a review of the ancient laws against the use of diseased meat, together with some account of the various attempts made in more recent times to regulate this traffic.

The two plans for the regulation of the sale of diseased meats are thus summarized: "*a*, All preventive measures may be reduced to the simple advice to cook the flesh well before eating it; and, *b*, Flesh of tuberculous animals should be confiscated, either in every case, or in certain circumstances." The first method of procedure is unsafe; because, in the first place, it would probably not be thoroughly done, and, in the second place, a recommendation alone would not influence in the least those who are in the habit of eating raw or almost raw meat (a common practice in Central and North Germany). The objections to, and the difficulties in the way of, the adoption of the second method, that of regulation, are mentioned, and discussed in an exhaustive manner; the effect of laws of partial or complete confiscation of affected animals is shown; the action of 'warranty' laws upon the morals of the butcher and owner, and the general effect of any attempt at regulation upon the cupidity of owners and of all concerned, are well illustrated.

A number of recommendations to the congress are made for adoption, too long for quotation, but seemingly based upon a firm ground-work of knowledge and experience. The report was brought on for discussion at so late a period in the session that not much was done in this direction. The sense of the meeting, however, seemed to be, that some law should be framed, restricting at least the sale of the meat of animals affected with tuberculosis.

The report, as a whole, contributes nothing, from an experimental point of view, to our knowledge of this disease, but, as before stated, is a very complete *résumé* of the question as it stands to-day in its hygienic and pecuniary relations. It will be of interest and importance to all veterinarians, as a summary of the knowledge thus far obtained, and as an index to the original sources from which this knowledge may be drawn. To scientific men actually engaged in the working-out of the problem of the etiology of tuberculosis, it can be of interest only as presenting the case from the veterinarian's stand-point.

The book is well gotten up, and clearly printed, but few errors having escaped the eye of the proof-reader. For ourselves, we should prefer cyst to *k*yst. The addition of an index would have made the book more serviceable to the general reader, and for purposes of reference.

The above articles are reprinted from several issues of SCIENCE. Pathology is ONE of the subjects demanding attention in such a journal.